Product Specification

MODEL 6450
CARTRIDGE TAPE SYSTEM

Kennedy Company
1600 Shamrock Avenue
Monrovia, California 91016

ector of Engineering _____ Project Engineer _____

e President, Marketing _____ Product Manager _____

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1.0 INTRODUCTION

1.1 SCOPE

This document defines the Kennedy Company Model 6450 Cartridge Tape System, consisting of the Model 640 Cartridge Drive and Model 650 Formatter, describing its physical and functional characteristics.

1.2 PURPOSE OF EQUIPMENT

The formatter is a miniaturized tape formatter module intended for use with Kennedy cartridge tape products. The formatter is designed to provide the functionality of large tape systems to small systems users. As such, particular attention is given to simplifying the interfacing and programming aspects of the device, since it is expected that most users will have microprocessor-based systems. Data backup to the Kennedy 8 inch disk product line is the main thrust of the cartridge tape system employing the formatter.

1.3 DESCRIPTION OF EQUIPMENT

The formatter is used with a single 6400 bpi serpentine cartridge tape drive (Model 640). It is physically mounted in the drive. It derives its electrical power from the same source as the drive. The formatter is intended for use in a radial interface configuration in conjunction with a simple DMA controller provided by the user.

The formatter is capable of controlling read/write functions formatted in a 6400 bpi self-clocking code format complete with serial error detection. Writing of file marks and standard tape motion commands such as space file and record forward/reverse are provided.

The formatter with an optimal data packing density of 4 Kbyte records can yield a packing density on a 450 ft DC300A ANSI/ECMA 1/4 inch 4 track cartridge in excess of 13.6 Mbytes formatted. When maximum records of 16 Kbytes are employed, the formatted density is in excess of 16 Mbytes.

1.4 APPLICABLE DOCUMENT

The following document will be referenced by number in this specification.

Pico Formatter Interface Definition — Kennedy PN 102-7002-001.
Programming Manual — Kennedy PN 102-0029-001.

2.0 PHYSICAL DESCRIPTION

This section describes the physical and electrical characteristics of the formatter.

2.1 DIMENSIONS

The formatter is packaged on a single 8.25" x 9.25" printed circuit card. The combined height of the card and components shall not exceed 0.5".

A 6450 system will be housed in an 8.5"W x 4.5"H x 16.5"D chassis with the 650 Formatter mounted behind the 640 Cartridge Tape Drive. The host interface connector and a power connector will be mounted on the rear of the chassis.

Track Select

TRK SEL A	TRK SEL B	PHYSICAL TRACK	ANSI TRACK
0	0	0	1
0	1	1	2
1	0	2	3
1	1	3	4

Figure 3-2 Track Selection

3.3.1.6 Threshold Select A (THRES A)

When combined with THRES B, this level selects one of three thresholds for read operations as indicated in Figure 3-3. These signals also control the CARTRIDGE RELEASE ENABLE function.

3.3.1.7 Threshold Select B (THRES B)

When combined with THRES A, this level selects one of three thresholds for read operations as indicated in Figure 3-3. These signals also control the CARTRIDGE RELEASE ENABLE function.

Threshold Select

THRES B	THRES A	THRESHOLD LEVEL
0	0	NORMAL
0	1	LOW
1	0	HIGH
1	1	CRE

Figure 3-3 Threshold Select

3.3.1.8 Set Write Status

When true (low) this level enables the write head driver selected by the TSA and TSB signal states. When false (high) this level disables the write heads.

3.3.2 Status Signals

3.3.2.1 Write Enable (SAFE/)

A low-true signal derived directly from the SAFE switch, WRITE ENABLE false indicates that the cartridge SAFE plug is in the SAFE position and that the cartridge can't be written on. When true, WRITE ENABLE indicates that the cartridge is not file protected (i.e., NOT SAFE) and may be written, since the SAFE switch now provides write current to the write head drivers. Note that this signal output is not switch debounced.

3.3.2.2 Cartridge In Place (CIP)

A level which goes true when the tape cartridge is locked into the transport and the tape transport is powered up. This signal is derived from the CARTRIDGE IN PLACE switch and is not debounced.

3.3.2.3 A Hole, B Hole

Used in conjunction with the FORWARD and REVERSE signals, these output levels provide position information for determining Beginning of Tape, Logical Load Point, Logical End of Tape, and End of Tape.

3.3.2.4 Forward, Reverse

These are low-true signals which signify the direction of tape motion. These output signals are derived directly from the motor tachometer.

3.3.3 Read/Write Signals

3.3.3.1 Read Data (RD)

Read data is presented in TTL compatible serial format and consists of coded flux transitions.

3.3.3.2 Write A (DATA)

Serial input data in the proper code format, including preamble, CRC, and postamble, is presented on this line. Write data consists of coded flux transitions. The polarity of this signal is such that a high (false) input state generates the ANSI standard erase polarity for gap generation.

3.3.3.3 Write B (STEP)

This signal line allows the user to modify the write current waveform in order to improve data recovery margins. The leading edge of the step pulses must be synchronized with the leading edge of the write data signal. A step pulse width of approximately one-half the bit cell time will give the best performance.

3.3.3.4 Write C (BIAS)

This signal line allows the user to modify the write current waveform in order to improve data recovery margins by reducing write to read crossfeed. The AC bias signal is a clock that runs at sixteen times the nominal data rate. Its leading edge must also be synchronized with the leading edge of the write data signal.

The input receiver circuits, due to low-true current sinking logic design, will interpet a disconnected wire or removal of power at the tape drive as a logic 0 or false condition. Each output line is driven with an open collector current-sinking logic driver capable of sinking up to 25 mA in the true state.

4.0 HOST INTERFACE

This section defines the Formatter-to-Host Interface. This interface is intended for use with microprocessor-based systems using DMA data transfer to and from the formatter.

Exact specification of the host interface will be found in the Pico Formatter Interface Definition, Kennedy PN 102-7002-001.

4.1 650 HOST INTERFACE TIMING SPECIFICATION

Nominal STRB width = 2 microsecond
Nominal STRB period = 42 microsecond during data transfers

5.0 FUNCTIONAL DEFINITION

All formatter functions are initiated by a command transfer while CBSY is false; one or more parameters may be transferred thereafter to or from the formatter, or read or write data may follow. This section defines the formatter functions in terms of the commands.

5.1 COMMAND FORMAT

Command bytes are formatted as positive binary integers. Valid commands (function codes) are in the range 00000000 — 00010000. All other function codes are illegal and will result in command errors.

This section describes the valid function codes. For brevity, the valid codes are referred to by their least significant five bits.

The host places a function code on the Data Bus with a CREQ, followed by a STRB sent by the formatter. Certain function codes will be followed with a series of bytes containing parameters required to perform the function. In the case of a Status Request the formatter will supply one or more bytes containing the status information. The drive will assert CBSY for all function codes.

5.2 FUNCTION CODES

The seventeen function codes are listed in Table 5-1 and individually described below.

5.2.1 Function Code 00000 (SENSE IDENTITY)

This command function requests an Identity byte from the formatter. After this command is sent to the formatter, the host will issue another CREQ which will cause the formatter to place the Identity byte on the Data Bus. The Identity byte is interpreted as a single eight-bit positive integer. A value of 00000001 identifies the device as a cartridge tape drive/formatter system.

5.2.2 Function Code 00001 (SENSE CONFIGURATION)

This function code is reserved for future use to define drive parameters. Not data will be transmitted or received and CBSY will go false with STRB.

5.2.3 Function Code 00010 (SENSE STATUS)

This function code will cause the formatter to input two status bytes which give the host a formatter/tape drive error summary and tape drive positional status. The host will output two CREQ pulses following the command. CBSY will remain true during the entire three byte transfer. The formatter will reset the error status bits after this function code is received and status is transmitted.

BYTE 1: SUMMARY STATUS

7	6	5	4	3	2	1	0
NOT READY	DRIVE FAULT	NO CART	FMTR ERROR	COMMAND ERROR	PARITY ERROR	LENGTH ERROR	DATA ERROR

NOT READY — The tape drive is not ready because a tape cartridge is not properly loaded.

DRIVE FAULT — A physical or electrical fault has occurred in the formatter/tape drive system or a broken tape condition exists.

NO CARTRIDGE — The tape cartridge is not inserted in the cartridge tape drive.

FORMATTER ERROR — The formatter has failed the self-test which is done during the execution of the load sequence, or noise was detected in gap region during a write. If this bit is set, off-line diagnostics are required to isolate the fault within the formatter board.

COMMAND ERROR — An illegal Function Code was sent. This may have been caused by a parity error (q.v.) or by a host processor error.

PARITY ERROR — The previous operation involved a Function Code, Address, or Data Byte with a parity error.

LENGTH ERROR — A one in this bit position indicates that a record in excess of 16 Kbytes has been transferred by the host. Only 16 Kbytes will be written on tape.

DATA ERROR — A tape record with a CRC or format error has been detected during a write or read operation. A faulty Erase will also issue a Data Error status.

BYTE 2: POSITION STATUS

7	6	5	4	3	2	1	0
LOGICAL LD PNT	LOGICAL EOT	FILE MARK	WRITE PROT	BOT	ALWAYS ZERO	TRACK BIT 1	TRACK BIT 0

LOGICAL LOAD POINT (LLP) — The formatter has detected and placed the tape at the Logical Load Point of the tape (Figure 5-1).

LOGICAL END OF TAPE (LEOT) — The formatter has detected the Logical End of Tape (Figure 5-1).

FILE MARK DETECTED — The formatter has detected the special File Mark character on tape.

WRITE PROTECT — The write protect plug on the tape cartridge has been detected.

BEGINNING OF TAPE (BOT) — Indicates the physical beginning of tape. This bit is returned after an Unload command (Figure 5-1).

TRACK SELECT BIT 1 — Along with track bit 0, track bit 1 defines the currently selected track.

TRACK SELECT BIT 0 — Along with track bit 1, track bit 0 defines the currently selected track.

Function Code	Function Name	Parameter from Host	Bytes to Host
00000	SENSE IDENTITY	0	1
00001	SENSE CONFIGURATION	0	0
00010	SENSE STATUS	0	2
00011	REWIND	0	0
00100	LOAD	0	0
00101	UNLOAD	0	0
00110	TRACK SELECT	1	0
00111	ERASE	0	0
01000	SPACE FWD	0	0
01001	SPACE REV	0	0
01010	SPACE FWD FM	0	0
01011	SPACE REV FM	0	0
01100	READ	0	0
01101	WRITE	0	0
01110	WRITE EXTENDED	0	0
01111	WRITE FM	0	0
10000	WRITE FM EXTENDED	0	0

Table 5-1 Function Codes

5.2.4 Function Code 00011 (REWIND)

This function code will cause the formatter to rewind and position the tape at Logical Load Point of Track 0 regardless of where the tape is initially positioned. CBSY will remain true from 1 millisecond to 60 seconds.

5.2.5 Function Code 00100 (LOAD)

This function code is employed whenever a cartridge is freshly loaded into the tape drive or whenever an initialize is required by the host. On operator loading of the cartridge Summary Status bit 5 (NO CART) will go false indicating the proper insertion of the cartridge. However, Summary Status bit 7 (Not Ready) will remain true. Prior to execution of the load sequence, the formatter will automatically perform a self-test of the formatter electronics. Successful completion of this self-test is required in order to proceed; otherwise the FMTR-ERROR bit will be set. The formatter will execute a routine to establish tape position and tension. On completion of the formatter routine Summary Status bit 7 (Not Ready) shall go false. The tape shall be positioned at Logical Load Point. CBSY will remain true from 1 to 60 sec depending on initial tape position of the freshly loaded cartridge.

5.2.6 Function Code 00101 (UNLOAD)

This function code will cause the formatter to rewind and position the tape at BOT. This will allow correct operator removal of the tape cartridge. CBSY will remain true from 1 millisecond to 60 seconds.

5.2.7 Function Code 00110 (TRACK SELECT)

This function code in combination with a Track Address/Placement byte will cause the formatter to select the track address and placement defined in the parameter byte, reposition the tape to LLP or LEOT (5 inches in front of the physical BOT or EOT depending on track address) of the selected track at a 90 ips rate and update the Position Status byte.

Employing this function code with function codes defined in Sections 5.2.8 through 5.2.16 will allow the Host to incorporate track selection to enhance file partitioning on tape. CBSY will remain true from 100 microseconds to 60 seconds.

7	6	5	4	3	2	1	0
TAPE POS	ALWAYS ZERO	ALWAYS ZERO	ALWAYS ZERO	ALWAYS ZERO	ALWAYS ZERO	TRACK BIT 1	TRACK BIT 0

BIT 7	BIT 1	BIT 0	TRACK ADDRESS	TAPE POSITION
0	0	0	0	LLP
0	0	1	1	LLP
0	1	0	2	LLP
0	1	1	3	LLP
1	0	0	0	LEOT
1	0	1	1	LEOT
1	1	0	2	LEOT
1	1	1	3	LEOT

Note: All references to tracks in this document are made to logical track address rather than ANSI track definitions.

5.2.8 Function Code 00111 (ERASE)

This function code causes the drive to erase tape at a 30 ips rate in the forward direction. The drive will sense LEOT and automatically stop. CBSY will go false allowing the Host to check Sense Status.

5.2.9 Function Code 01000 (SPACE FORWARD)

This function code causes the drive to proceed from an IBG (Inter Block Gap) at 30 ips and move to the next IBG. One record on tape will be traversed. This function is constrained to the current Track Address. If a File Mark or LEOT is encountered during the Space Forward, it will be reported in the Position Status byte.

5.2.10 Function Code 01001 (SPACE REVERSE)

This function code causes the drive to proceed from an IBG at 30 ips and move in the reverse direction to previous IBG. One record on tape will be traversed. This function is constrained to the current Track Address. If a File Mark or LLP is encountered during the Space Reverse, it will be reported in the Position Status byte.

5.2.11 Function Code 01010 (SPACE FORWARD FM)

This function code causes the drive to proceed at a 30 ips rate in the forward direction until a File Mark (FM) is sensed. When a tape File Mark is encountered the drive will ramp to a stop in the IBG following the FM. The Drive Position Status byte will indicate that a FM was found. CBSY will go false when a FM is encountered. If no FM is sensed, the formatter will stop the drive at LEOT.

5.2.12 Function Code 01011 (SPACE REVERSE FM)

This function code causes the drive to proceed at a 30 ips rate in the reverse direction until a File Mark (FM) is sensed. When a tape File Mark is encountered the drive will ramp to a stop in the IBG following the FM. The Drive Position Status byte will indicate that a FM was found. CBSY will go false when FM is encountered. If no FM is sensed, the formatter will stop the drive at LLP.

5.2.13 Function Code 01100 (READ)

This function code causes the formatter to read one tape record in the forward direction. After the host issues the command, the formatter will set CBSY true. The host then sets DRDY true. The formatter will only then start the drive in motion. When the drive is up to proper speed, the formatter will set DSBY true. A minimum of 10 microseconds later the first decoded data byte will be available to the host on the data bus with its associated strobe pulse. STRB pulses shall be issued continuously until the end of the record; at that time DBSY and CBSY will go false. The formatter decodes the data, strips off special format characters, checks the integrity of these characters, and detects data errors through the use of a CRC (Cyclical Redundancy Check) character.

5.2.14 Function Code 01101 (WRITE)

This function causes a record to be written on tape with standard IBG's. After the host issues the command, the formatter will set CBSY true. The host then sets DRDY true. The formatter will only then start the drive in motion. When the drive is up to proper speed, the formatter will set DBSY true. A minimum of 10 microseconds later the first STRB will be issued to transfer the first byte of data from the host to the formatter. STRB pulses shall be issued continuously until DRDY goes false from the host or until 16 Kbytes are transferred. If 10 Kbytes are sent, DBSY and CBSY will go false as the record is completed. The Length Error bit will be set in the Position Status byte.

The formatter will perform a read-after-write as the record is being written. Improperly written special format characters or a CRC failure will result in the Data Error Status bit being set true.

Write commands initiated from LLP will start the actual writing of data 3 inches from the LLP hole (Figure 5-1).

Before all Write commands are attempted by the host, the Write Protected bit (Position Status bit 4) should be checked. A Command Error bit status will be returned if a write is attempted on a write protected cartridge.

5.2.15 Function Code 01110 (WRITE EXTENDED)

This function causes an erased gap of approximately 3 inches to be placed on tape prior to writing the tape record. This is done to lower the risk of encountering a physical failure area on tape that may have caused a data error when a write was previously attempted. This function should be employed after a write function with a read-after-write error and a subsequent host initiated space reverse. This function assumes that blank tape exists beyond the record being written.

Write Extended cannot be used when the record to be rewritten was written past the LEOT of tape. The Command Error and LEOT bits will be set in the status words if Write Extended is attempted under this condition.

Write Extended should not be used to perform editing as loss of position will result.

5.2.16 Function Code 01111 (WRITE FM)

This function causes the formatter to write a special coded field on tape to be employed as a tape File Mark. Standard IBG's will be placed on either side of the special field.

5.2.17 Function Code 10000 (WRITE FM EXTENDED)

This function causes an erased gap of approximately 3 inches to be placed on tape prior to writing the File Mark. This is done to lower the risk of encountering a physical failure area on tape that may have caused a data error when a Write FM was previously attempted. This function should be employed after a Write FM function with a read-after-write error and a subsequent host initiated space reverse. This function assumes that blank tape exists beyond the record being written.

Write FM Extended cannot be used when the File Mark to be rewritten was written past the LEOT of tape. The Command Error and LEOT bits will be set in the status words if Write FM Extended is attempted under this condition.

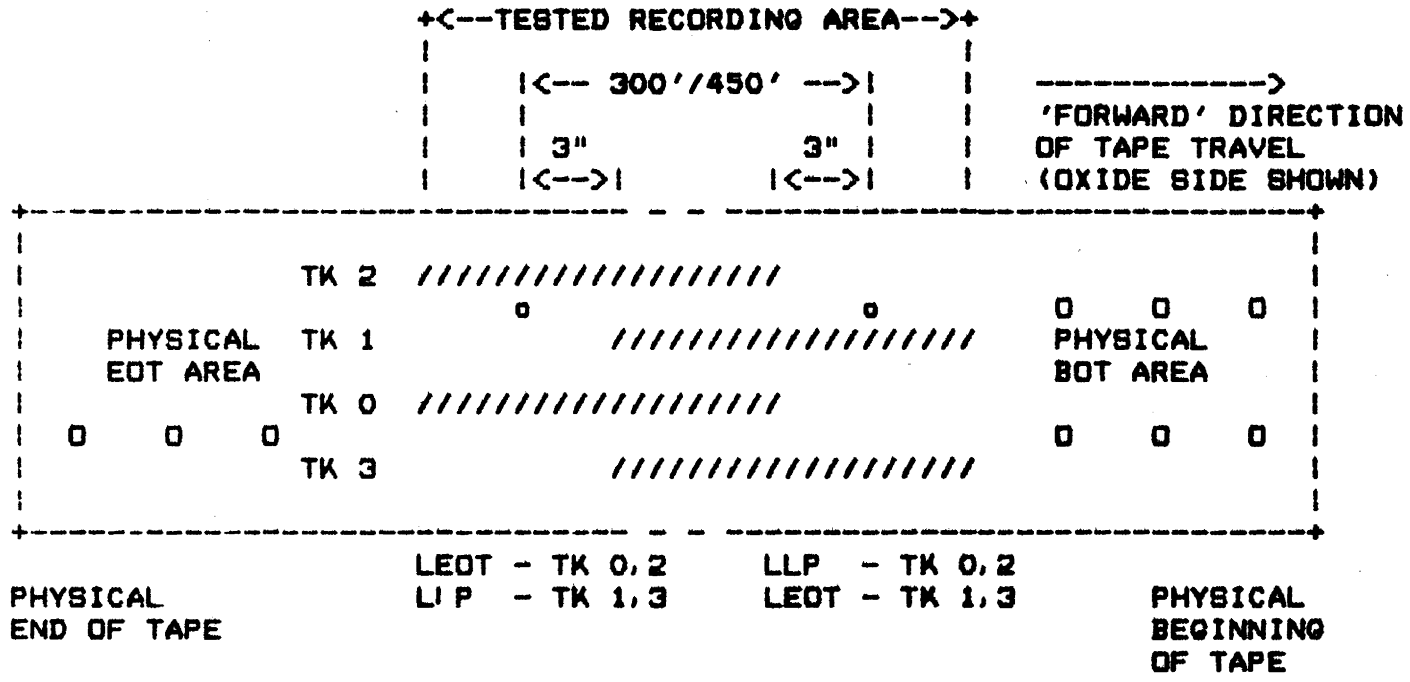

Figure 5-1 Tape Position Holes

6.0 FORMAT DESCRIPTION

This section describes the tape format in which user data is written on tape.

6.1 DATA ENCODING

The formatter shall encode the host output data bytes into a high efficiency 4-to-5 bit run-length encoded data stream.

6.2 DATA RECORD STRUCTURE

The formatter shall write the host data bytes serially on tape followed by the CRC character. This encoded field will be flanked by a preamble and postamble.

6.3 CRC CHARACTER

A 16 bit CRC character shall be generated by the formatter on the host data bytes. The resultant 16 bit value will be written on tape following the user data field. During read or read after write operations, this 16 bit value will be compared with a regenerated value. A discrepancy between the two will indicate a data error, which will be reported by the Summary Status byte.

6.4 TAPE FILE MARK (FM)

The File Mark shall be a preamble, special field, and postamble combination. Standard IBGs shall be employed on either side of the File Mark.

6.5 Inter Block Gaps (IBG)

The standard IBGs between records or File Marks written on tape (except from Load Point) shall be a minimum of 1.2 inches (30.5 mm).

The standard gap when writing from Load Point to the first record or FM shall be 3.0 inches (76.2 mm).

7.0 PROGRAMMING

This section describes the recommended programming sequences to operate the 650 Formatter.

7.1 CONTROLLER

The host is assumed to communicate with the formatter through a controller supplied by the user. In general, this controller should have the following characteristics:

(1) A DMA device capable of transferring data at a rate of up to 24,000 bytes/second.
(2) A Bus Control which maps the host's internal I/O structure onto CREQ and STRB.
(3) An Interrupt Control which can interrupt the host on "not CBSY" (CBSY line goes false).
(4) A Drive Select Control if more than one drive is to be connected radially to the controller.

In what follows, it will be assumed that only one drive is connected to the controller. The I/O ports which the host will require on the controller will then be:

(1) The ports to set up and test the DMA device.
(2) The ports which correspond to the Data Bus.
(3) A port through which the host can test STRB, CBSY, and parity error.

The controller may optionally insert wait states during a CREQ/STRB transfer to achieve proper signal timing.

7.2 CONTROLLER PROGRAMMING

Since the controller configuration is defined by the user, no recommendations will be made regarding its programming. It is assumed that the Host processor is capable of setting DMA pointers, testing DMA status, and multiplexing the Data Bus between DMA and programmed I/O.

7.3 FORMATTER PROGRAMMING

This section describes the recommended sequences for performing status testing, normal commands, and error recovery with the formatter.

7.3.1 Status Testing

The Sense Status function code should be commanded by the host following each formatter operation (Load, Space, Read, etc.) and before beginning a new operation if the drive has been idle.

Reading of the Sense Status bytes should not be attempted unless it is known that the DMA device in the controller is idle and disconnected from the formatter host Interface.

The following sequence is recommended upon interruption by "not CBSY":

(1) Disable DMA device.
(2) Output Sense Status command.
(3) Input Summary Status Byte.
(4) Input Position Status Byte.
(5) Read DMA device status.
(6) Read DMA device registers (if Data operation) to determine successful completion.

If Summary Status reflects a Command Error (bit 3), no operation has been performed. If Parity Error (bit 4) is set, this was due to an interface failure. Otherwise it was due to transmission of an illegal function code or code sequence (Command Error).

If Summary Status reflects a Not Ready (Bit 7), bits 4 (Formatter Error), 5 (No Cartridge) and 6 (Drive Fault) should be consulted to determine the cause. If the consulted bits 4, 5, and 6 are false, the host should command a Load. Not Ready will go false upon successful completion. The drive will perform no other commands until Not Ready is false.

Following a data operation, the DMA device registers should be checked to ensure that the correct number of bytes was read or written. If this is not the case, then either the DMA device failed to transfer data at the correct rate or the 16 Kbyte record maximum was reached before the transfer was completed. The host can distinguish these cases by rechecking the length of the transfer and the Length Error bit (Bit 1) in the Summary Status byte.

7.3.2 Operations

The following sequences assume that DMA idle and drive idle (Summary Status byte = all zeros) have been established.

7.3.2.1 Track Select

The following sequence will cause a valid Track Select:

(1) Output the Track Select command.
(2) Enable interrupt from controller on "not BUSY".
(3) Output the Track Select Address byte.

The Sense Status bytes following the operation will reflect all zero and the appropriate tape position status, respectively, if the operation was successful or Drive Fault status in the event of a repositioning error in the Track Select process.

Note: As mentioned in section 5.2.7, the Track Select command may be employed in those instances where a reduction in file access time is desirable. For example, the first record on track 0 could define tape partitioning with Track Addresses included. If, however, use of this command is not anticipated, the formatter will maintain Track Address internally in a logical sequence.

Track Select also allows rapid movement of tape to simulate a Fast Forward or Fast Reverse mode by moving at a 90 ips rate to the LLP of the track selected.

7.3.2.2 Data Operations

The following sequence assumes that the tape drive is positioned in an IBG or at LLP before the commands are issued.

(1) Output Track Select function code if employed.
(2) Set up DMA device.
(3) Output Read, Write, or other data command.
(4) Enable interrupt from controller on "not CBSY".
(5) Enable DMA device. Normally, this should also set DRDY true. DRDY stays until DMA end of data.

Normal completion of a data operation will result in a "not CBSY" interrupt.

Note: Write retries attempted at the LEOT of tape will not be performed. The correct retry sequence should simply erase the erroneous record rather than attempting to rewrite it.

7.3.2.3 Tape Unloading

The following sequence should be employed when a tape cartridge is to be removed from the tape drive.

(1) Output Unload command.
(2) Enable interrupt from controller on "not CBSY".
(3) On interrupt, sense Status bytes.
(4) Test bit 7 of Summary Status and bit 3 of Position Status byte. Bit 7 (Not Ready) and bit 3 (BOT) should be true.
(5) Operator can now remove cartridge from drive.

7.3.3 Error Recovery

Abnormal (nonzero) Summary Status following a motion or data operation requires a recovery sequence. This section describes several such sequences for common errors.

7.3.3.1 Drive Fault

If bit 6 (Drive Fault) of the Summary Status byte is set following an operation, it signifies the occurrence of one of several types of fault. The Sense Status command should be sent again to see if the fault was cleared by the previous Sense Status query. If this is not successful, the drive must be considered inoperable. If it is successful, the operation may be retried.

7.3.3.2 Parity Error

Parity Error status (Summary Status byte, bit 4) following any operation indicates a received parity error during setup or execution. If the Command Error (bit 3) is not set, the error occurred in a data transfer (Write Data or Write Extended).

Parity errors may be caused by electrical transients, poor cable connection, or component failure. The entire operation sequence should be retried after repositioning the tape to previous IBG.

The host system may log parity errors, or measure the rate of occurrence, in order to anticipate the need for maintenance or repair of the interface.

7.3.3.3 Data Error

Data Error status (Summary Status byte, bit 0) may be set following a data operation due to an unreadable record (read or write operation).

If the Data Error status bit is set and the LEOT status bit is NOT set, the proper retry sequence is Space Reverse followed by Write Extended, Write FM Extended or Read as appropriate. Read retries should be attempted at least ten times.

If the Data Error status bit is set and the LEOT status bit is set, the proper sequence is Space Reverse followed by Erase. Write Extended or Write FM Extended cannot be employed when the erroneous record is at or after LEOT. Attempts to use these commands will result in a Command Error with LEOT status reported.

7.3.3.4 Length Error

Bit 1 of the Summary Status byte indicates a record length error during a data operation. A Length Error will occur if the host attempts to write more than 16 Kbytes in a record, or if poor tape data quality obliterates end of record detection during a read operation. A Space Reverse command should be sent followed in the former case by a Write Extended command and in the latter by another Read command.

7.3.3.5 Formatter Error

If bit 4 (Formatter Error) of the Summary Status byte is set following the LOAD commands, it signifies that the formatter failed its own internal self-test. Off-line diagnostics should be performed on the formatter to isolate the cause of the fault.

7.3.3.6 Interface Time-Out

The host is assumed to have a mechanism which will generate an interrupt if a STRB is not received in response to a CREQ within a fixed time. For the formatter, the appropriate time-out is not less than 500 microseconds. An interface time-out interrupt will then indicate that either the interface has failed, no drive is connected, or CREQ was transmitted when the formatter did not expect it. It is recommended that a standard sequence of transfers be attempted to determine the cause.

8.0 DIAGNOSTICS

This section describes the on-line and off-line diagnostics routines used to isolate faults within the 6450 Drive-Formatter subsystem.

8.1 ON-LINE DIAGNOSTICS

The formatter performs a self-test routine prior to each LOAD command. Successful completion of the self-test is required before the rest of the load sequence is allowed to continue. The self-test routine is a loop write to read of a file mark. This effectively stimulates about 80% of the formatter circuitry, including the data separation circuit. If the self-test fails, further off-line testing is necessary.

8.2 OFF-LINE DIAGNOSTICS

The off-line diagnostics are selected by setting switch 7 "on" of the eight-position DIP switch located on the formatter. Once off-line diagnostics are selected, there are up to sixteen test routines that can be chosen. Prior to running of the off-line diagnostics, a kernel (or sanity) test should be run on the 8039 microprocessor and the associated PROM memory. This will verify that this part of the system is functional, so that the other tests that are in program memory can be run.

Note: To run off-line diagnostics

(1) Set Switch 7 to ON position.
(2) Disconnect Interface cable from host to protect Formatter Interface drivers.
(3) Check tape cartridge to guarantee that it is not in the "safe" position.

8.2.1 Tape Drive Diagnostics

8.2.1.1 Continuous Load

This routine performs up to sixteen continuous LOAD sequences (without the self-test routine). This allows the duration of the A and B holes to be measured along with the basic functioning of the 640 Control board.

8.2.1.2 Ramp Adjust

This test in combination with the ramp adjust potentiometer found on the Control board will adjust the system for proper ramp times. When the proper ramp time is reached the tape will shuttle back and forth. If the ramp time is incorrect the tape will move in the forward direction only.

8.2.1.3 Tape Speed Adjust

This routine employing the continuous writing of file marks allows accurate adjustment of the tape speed when employed with the speed adjustment potentiometer foundon the Control board. The tape will continue to move in the forward direction until the proper speed is adjusted; at that point the tape will shuttle back and forth to indicate proper adjustment.

8.2.2 System Diagnostics

8.2.2.1 Write File Mark Continuous

This routine will write file marks on the selected track until the Logical End of Tape is seen. If a bad file mark is written, a SPACE REVERSE will be performed and the file mark will be rewritten.

8.2.2.2 Read Continuous

This routine will read blocks of data or file marks on the selected track until the Logical End of Tape is seen.

8.2.2.3 Write Continuous

This routine will write short blocks of data on the selected track until the Logical End of Tape is seen. If a bad block is written, a SPACE REVERSE will be performed followed by a WRITE EXTENDED routine. This will be repeated, if necessary, until a good block is written.

8.2.2.4 Tape Erase

This routine starts at the Logical Load Point of track 0 and erases the entire length of tape. At the end of track 3 the tape will unload.

8.2.3 Formatter Diagnostics

The formatter diagnostics take advantage of the power of Signature Analysis (SA) to isolate faults to the component level. Certain jumpers are required to set up the SA tests. These are documented in the user's manual. An HP 5004A Signature Analyzer is required for these tests as well as for the kernel test of the 8039.

8.2.3.1 Controller SA

This routine stimulates all the nodes in the controller section of the formatter so that any faults in this section can be isolated down to the component responsible.

8.2.3.2 Read Sequencer SA

This routine stimulates all the nodes in the read sequencer section of the formatter so that any faults in this section can be isolated down to the component responsible.

8.2.3.3 Write Sequencer SA

This routine stimulates all the nodes in the write sequencer section of the formatter so that any faults in this section can be isolated down to the component responsible.

8.2.3.4 Continuous Self-Test

This routine performs continuous self-test routines that allow the data separator section including the phase lock-loop to be tested and adjusted. This is also a good verification of the functioning of the formatter as a whole.

DIAGNOSTIC SWITCH SETTINGS

diagnostic routine	switch settings (at A1 on PCBA) 1	2	3	4	5	6	7	8
0) continuos load							*	
1) ramp adjust	*						*	
2) speed adjust		*					*	
3) write FM cont.	*	*					*	
4) read continuous			*				*	
5) write continuous	*		*				*	
6) controller SA		*	*				*	
7) read seq. SA	*	*	*				*	
8) write seq. SA				*			*	
9) cont. self test	*			*			*	
10) tape erase		*		*			*	

Notes:
1. * indicates that switch should be in the ON position
2. System Reset (switch number 8) must be switched on to initiate a diagnostic routine and switched off to terminate a diagnostic routine.